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Unravelling the mysteries of hopping

How can kangaroos travel at high speeds without tiring? What is the mechanism that enables them to use the same amount of energy when hopping at a slow and a fast speed?

As part of an ongoing study on the energetics of locomotion which has included animals ranging from llamas to crabs, graduate students Rodger Kram and Claire Farley are putting "Arthur," the four-year old red kangaroo, through his paces at the MCZ's Concord Field Station to better understand how this animal works. Kram's measurements have shown that a steady rate of energy is used at varying speeds. Farley, observing that the kangaroo hops the same number of times per minute regardless of the speed (he simply varies the length of each hop to travel faster), compares the mechanism to that of a spring or a high density rubber ball which maintains a steady rate once set in motion.

Farley has attempted to convince Arthur to hop at a different frequency, but with an intelligence level comparable to that of a sheep, it has not been easy. Reversing the usual



Claire Farley with "Juanito" the llama, one of the animals studied at the Concord Field Station.

procedure, she has resorted to using human subjects to better understand the animal. She has found that humans also have a set rate at which they hop—all humans tend to hop

twice per second—and find it difficult to alter the rate. A metronome has proved helpful for this purpose.

If a kangaroo doesn't tire at faster speeds, why doesn't it travel at faster speeds all the time? The energy cost studies show that the animal has a preferred speed which is far below its maximum capacity. Kram speculates that the increased force on its limbs may be painful. Since in their natural habitat the kangaroo has no predators, speed is not an important element to survival. However, it might be adapted for steady long-distance travel in search of water in its desert home.

There is a catch to the kangaroo's seeming ability to stay effortlessly in perpetual motion. It can only do so on level ground. On an incline, it tires rapidly.



Rodger Kram feeds "Arthur," a red kangaroo.

Patterns of Lives in Science: James J. McCarthy

by Hilary Hopkins

Professor James J. McCarthy, Director of the Museum of Comparative Zoology, was speaking of his grandfather. "He probably gave me—yes, he certainly gave me—a great deal of confidence that no matter how complicated a piece of machinery is, you can always figure out how it works, and in fact if you're at all clever, you can figure out how to keep it working. I'm sure that attitude was very influential in my early days," he added.

A confident pursuit in search of the workings of complicated things seem to have characterized not only Professor McCarthy's very earliest years, but to have continued growing in scope and complexity.

McCarthy grew up in a small lumbering community in the foothills of the Willamette Valley, in Oregon. "I was intensely curious about everything I could see. I joined the local group of bird-watchers, collected all the bugs I could find, all the bird nests, snakes—I used to catch chipmunks in the yard and keep them. I guess it wasn't the nicest thing to do, but I had some of them for several years! My curiosity about the creatures around me goes back just as far as I have memories, probably around three years old. At every opportunity I would be outside, and that continued through high school—hiking, hunting, fishing, skiing, mountain climbing. It was an environment I was always trying to scheme to be in as much as possible."

I asked about his early experiences at school. "I had two superb teachers in elementary school," he said. "They gave me a lot of opportunity to do some fairly unsupervised discovery of new and exciting information, beyond the regular lessons. My high school science classes were adequate; they taught me the facts of science. But I didn't have a very good

sense of where the interesting opportunities for discovery were. It was pretty much presented as, 'Here's the way the world is.'"

"Kids usually aren't taught that there is much in science that remains unknown; they get the impression that science as presented is a comprehensive and thorough body of knowledge."

"We work very hard to dispel that myth through our educational programs here at the Museum," Professor McCarthy noted.

He described to me how he threw an increasingly wider net as he grew older. "When I first went to college I was thinking seriously about pre-law. Even so, I declared biology as a major, but then at the end of my third year I was balanced between biology, chemistry, philosophy, and art history. I really found that I was as interested in chemistry as I was in biology, and I found physics equally fascinating."

Fortunately, a greatest common denominator, as he styled it, became apparent among these engaging topics. "That sense of broad interests across the disciplines of basic sciences led me to look very seriously at ocean science. In order to deal with the biology of the oceans you must also deal with the chemistry, and it's impossible to do that without dealing with the physics. And it's a science where I can work close to the subject matter."

Both the need to observe the natural world and to understand the interaction of its elements are satisfied in McCarthy's preferred style of learning and working. There was a long pause when I asked him about his special abilities as a scientist, and how he goes about solving problems. "You asked me a very difficult question, Hilary," he said finally. "I suppose it would be my ability to make observations of natural processes that lead to experiments, experiments that test variables one by one, to see which variable is most important, or most responsible, for the pattern I see in nature, both patterns in time and patterns in space. In my mind I try to develop a class of hypotheses which could conceiv-

ably explain a particular pattern—the abundance of a certain type of organism in a certain region at a certain time of year, or maybe greater abundance near to the surface of the ocean than at 50 meters, or whatever."

"You're describing a very orderly process," I interjected. "Is it really that way?"

"What isn't orderly is the initial observations," he responded. "I wouldn't know how to say, 'OK, what am I going to see next, how can I best make the critical observations?' The observations come unscheduled, often in clusters, and often not as frequently as you would like. The field work is where I really have the opportunity to see, literally as well as figuratively, how the system is working. Not just what one sees with one's eyes over the side of the ship, but the data as they come on board. You're thinking, 'What does this mean? What does this vertical profile mean compared with that one? How is it different from yesterday?' You can respond to that, in real time, by saying, 'Aha! We're going to change our sampling strategy, we're going to measure something differently, we're going to bring some of these organisms into the laboratory and do something we hadn't even imagined a day ago, because of this observation.' The field experience is just rich with that kind of opportunity," he said enthusiastically.

In short, I thought to myself, "How does this complicated piece of machinery work?"

McCarthy is deeply concerned with the increasingly daunting problem of how human activity influences the workings of the Earth system. In this aspect of his work he also synthesizes input from a diversity of sources. During our conversation the fax machine next to his desk began churning and continued to do so for quite some time. "This is the report from Stockholm of the last meeting of a committee I'm chairman of," he explained as the printout continued. "There are eighteen members from fifteen nations. It's called the International Geosphere-Biosphere Programme. We're organizing research efforts for

Hilary Hopkins, a Friend of the MCZ since 1981, is a science enthusiast and educational consultant specializing in gifted children. This article is the fourth of a series she has prepared for the MCZ Newsletter.



MCZ Director Jim McCarthy (right) discusses with the Soviet Minister of Culture, Juri S. Melentiev, how entomologists like Nabokov use the morphology of butterfly genitalia to distinguish between closely related species.

the years ahead that deal with the interactions in Earth's system that we know to be essential to the prescription for habitability on this planet, and that we know to be subject to human perturbations."

"It's a difficult balancing act, being as involved as I am in international scientific organizations now," Professor McCarthy commented. "It's a tremendous distraction. But also it's a fabulous opportunity to help nurture some of this interdisciplinary interaction that I feel so strongly about."

Earlier as we'd been speaking of his grandfather, Professor McCarthy commented that he'd been very skilled at woodworking and at making just about anything anyone needed. "Do you have things that he made?" I asked.

"Yes, yes, we do. And in fact, not only that, but I still carry his pocket watch, which actually belonged to his father." He reached into his pocket, drew out the watch, and handed it to me across his desk.

It was a lovely golden thing, weighty and smooth. The back was delicately engraved with an inviting outdoor scene of a cottage amid pines and hills. It seemed to be keeping perfect time, to be in perfect working order, a complicated little machine, cherished and attended to carefully by its steward. I thought it a fine metaphor of a life in science spent observing the natural world, trying to figure out its interlocking parts and how best to keep them working.

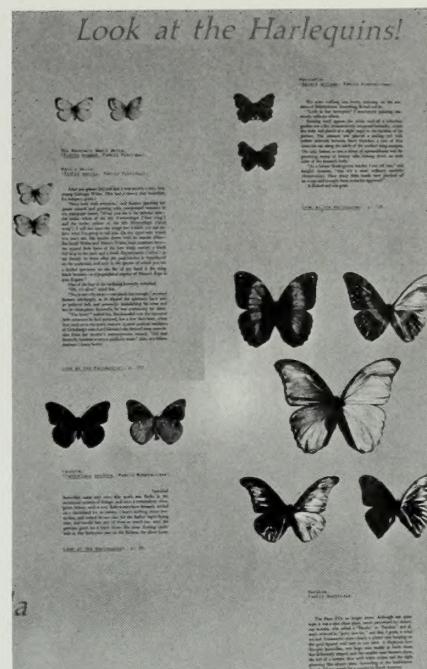
Nabokov's Butterflies

The butterflies of Vladimir Nabokov fluttered back to life this January, alighting in cases arranged against lilac-tinted walls and drawing rave reviews in the press and from museum goers. Assembled by Ed Haack with help and advice from Ed Armstrong, Deane Bowers, and Bob Davidson, the special exhibition "Nabokov's Butterflies" interwove the scientific and literary elements of Nabokov's work with an elegance, subtlety and beauty that the exacting Russian/American master would have appreciated.

Although small in terms of actual space, the exhibition managed to encompass much of Nabokov's multifaceted life in literature and lepidoptera. Included was a case of "blues," specimens from the genus *Lycaeides*, which the novelist worked on while a research fellow in the Department of Entomology from 1941 to 1948. The section on memorabilia contained photographs, letters, and signed books, notably a first edition of Nabokov's *Gogol*, the inscription of which had ink drawings of butterflies, including the tiny, pesky *papillons de nuit*. In one space, just above a stand with journals containing some of Nabokov's scientific papers, was a map of the United States showing the butterfly collecting trips he took during the summers with his wife Vera. In the most striking part of the exhibition, quotes from Nabokov's novels, memoirs, letters mentioning butterflies were set in large type next to the actual specimens.

Robert Taylor in the *Globe* penned one of the more glowing reviews, calling the exhibition "the expression of a Nabokovian attitude, a way of regarding experience, of life irradiated by art, and art exalted by its foundation in nature's details."

Among the many visitors to the exhibition were several prominent Russians, including Mr. Juri S. Melentiev, the Soviet Minister of Culture. The Minister expressed an avid interest in the works of Nabokov, and took many notes as he and a translator viewed the exhibit.



Several cases consisted of quotes from Nabokov's works about butterflies and moths along with the actual specimen mentioned.

Staff Notes

Going West . . . Missoula, Montana seems to hold a special attraction for Harvard anatomists. First, **Don Fawcett**, formerly of Harvard Medical School, former member of the Faculty of the MCZ, and a long-time loyal MCZ Friend, chose Missoula, at the foot of the Rockies, as the ideal retirement location and now **Kenneth Dial** has been appointed Assistant Professor in the Department of Zoology at the University of Montana and will follow. Dial has been a post-doctoral fellow working with **Professor Farish A. Jenkins, Jr.** on the mechanics of bird flight and also co-led the MCZ safari to Kenya in February. In Montana, Dial will be teaching courses on human anatomy and physiology. **Alfred Alcorn**, Assistant for Membership and Travel, is currently being interviewed by radio, television, and the print media in connection with the publication by Houghton-Mifflin of his second novel, *Vestments*. The first one, *The Pull of the Earth*, published in 1986, was translated into several languages and was reprinted as a Penguin paperback.

Open Houses Attract Record Crowds

by Arlene Nichols, Education Director

Parents and siblings of the third and fourth grade students who participate in the Cambridge Schools Museum Project braved heavy spring rains to attend their annual Museum Open House on the evenings of April 27 and 28. Almost 300 visitors on the second evening broke the attendance records of the previous five years and included Cambridge Schools administrators, teachers, and school committee members, as well as parents, taking part in student-planned scavenger hunts and displays. A visiting rat snake and the self-operating slide show depicting students at work in the MCZ were stiff competition for the MCZ's permanent exhibits.

Overheard remarks — "I didn't realize what an exciting place the MCZ is!" and "I wish I were in the fourth grade again so I could do this program" — all demonstrated the value of the extra work on the part of the MCZ staff and Museum Guides to create the displays and activities. In this final year of Massachusetts Council on the Arts and Humanities seed money for the program the Cambridge community has demonstrated their appreciation of the MCZ's role in extending the science education of their children by their attendance, their offers to assist in fund-raising, and the food donations from local businesses for the Open House. New sources of support are essential if we are to continue this program in the coming year.

If the MCZ seems to reverberate a little less in the late Spring, it is because the Cambridge students are doing the "field work" at Habitat Institute for the Environment during

May. Our goal is to make it possible for them to return to the MCZ in the fall.

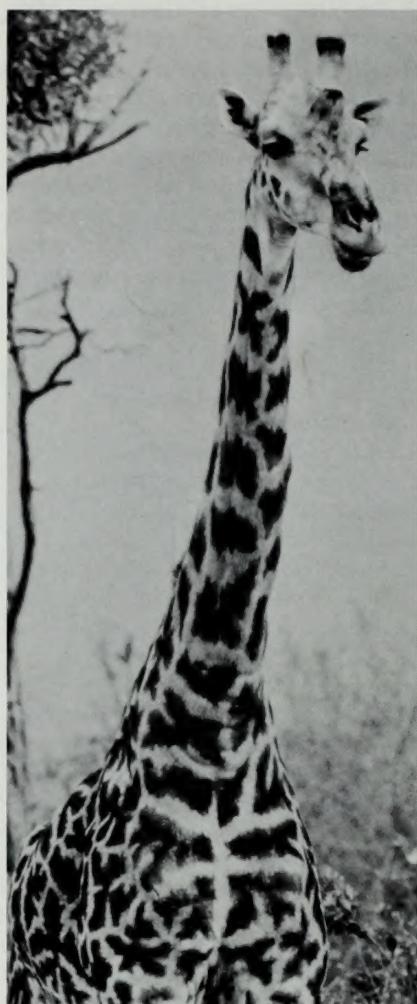


Photo by Kenneth Dial

Travel Program

This has been a record year so far for our natural history expeditions. Three more trips leave in August: a Kenya safari, a Tanzania tenting safari, and a cruise in the Galapagos Islands. Our final 1988 expedition is to Brazil and Argentina (October 15 to November 1), jointly sponsored with Roger Payne's Long Term Research Institute.

A variety of exciting programs are planned for 1989. *Around the World in 80 Minutes*, an evening to preview the trips, meet the scientific guides, sample native foods, and see examples of the local fauna, will be held on September 20. 1989 trips include:

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January 9–25 Antarctica and the Falklands: Cruising through the icebound splendor of Antarctica aboard the *Society Explorer* at the peak of the season for seeing penguins with their chicks. Led by Farish A. Jenkins, Jr.

January 11–27 Tanzania Tenting February 9–25 Safari: Two classic tenting safaris featuring visits to Lake Manyara, Serengeti National Park, Olduvai Gorge, and Ngorongoro Crater. Led by Rob Dorit and Gillian Kendall (January) and Steven Austad and Marc Allard (February).

February 19– Costa Rica's National Parks: a tour of some of the outstanding natural areas including Manuel Antonio National Park, Santa Rosa, and Monteverde Cloud Forest. Led by Kurt Fristrup.

February 28– Lands of Humboldt and Darwin: cruise up the Chilean coast from Puerto Montt to Arica with extensive land expeditions, a pre-trip to the Chilean lake district and an optional extension to the Galapagos Islands. Led by Mark Skinner and Alfred Alcorn.

March 18– April 10 Australia in Depth: a thorough exploration of the eastern side including Sydney, Brisbane, Lamington, Great Barrier Reef, Cairns, Kakadu, Melbourne, and five days in Tasmania. Optional extension to Alice Springs/Ayer's Rock. Led by Randy and Molly Olson.

July 8–24 Beyond the North Cape: cruise aboard the *M.S. Polaris* from Edinburgh to Spitsbergen. Led by James J. McCarthy.

August 4–20 Zambia, Botswana & Zimbabwe: repeat of this popular safari which includes visits to the Luangwa Valley, the Okavanga Delta, and Victoria Falls. Leader to be announced.

August 17– September 15 Foothills of the Himalayas: an in-depth tour including Islamabad, Gilgit, Hunza, Kashmir, Corbett, a week in Bhutan, and Manas National Park. Led by John D. Constable, Gabrielle Whitehouse, and local naturalist Sunjoy Monga.

